OBSERVATION OF OCEANIC OSCILLATION PHASES AND THEIR RELATIONSHIP TO WEATHER PATTERNS:

CAN MULTIPLE OSCILLATIONS BE USED TO MAKE CLIMATE PREDICTIONS?

Lyle D. Birkey*

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NOAA/OAR/OGP

Washington D.C., U.S.A.

ABSTRACT-The complex workings of our climate system are reliant upon many factors. Each contributing factor plays a distinct role, and particular modes of variability have differing influence on the climate of specific regions. The modes of variability are described as "oscillations." The best known oscillations are the El Niño/Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), and the North Atlantic Oscillation (NAO). They play a significant role in the climatic variability of many regions throughout our earth. In most studies of the relationship between oceanic oscillations and climate, the tendency is to focus on only one oscillation at a time and to look at how that <u>one</u> oscillation is related to global or regional climate.. This paper postulates that by applying ENSO, PDO, and NAO information simultaneously, greater predictive skill of regional climate patterns can be derived.

1-INTRODUCTION

While looking at literature published about the Pacific Decadal Oscillation (PDO), the North Atlantic Oscillation (NAO), and the El Niño/Southern Oscillation (ENSO), the quantitative variation of publications between one

**Mr. Birkey is an incoming senior at Grant High School in Portland, OR. Please direct any questions to Mr. Birkey at macomatic3@aol.com.*

oscillation and the next is noticed. The measure of scientific publications for the ENSO oscillation far exceeds that of either the PDO or NAO. One might even venture a guess that the cumulative publications of PDO and NAO combined are fewer than the number of publications regarding El Niño alone.

A possibility of why El Niño is more publicized than the other oscillations is because of its history. While El Niño has been identified for decades, the PDO hadn't been named until 1998. Due to the long-term periods (decades) of the PDO and the NAO oscillations, they are not as noticeable as a shorter oscillation such as ENSO (1-3 years). In the average human's life span, a climatic variance with a positive/negative regime of twenty to thirty years is not easily recognized by a single individual's observation. Only through analyzing a long-term data records, say one hundred years (or longer), of sea surface temperature (SST) data can the oscillation be observed.

Although less known than El Niño, the PDO and NAO have an undeniable effect on climate. This paper proposes that the PDO, NAO, and ENSO can have additive, and sometimes canceling effects on the climate of a region. How, exactly, these three oscillations are related is largely unknown; but what is recorded, are yearly climate averages for the past century. With this known, two years (which have similar phases of PDO, NAO, and ENSO) may be seen as having similar or divergent climate. If what I postulate in this paper is correct, then the two selected years will show some amount of climatic similarity. Also, if the theory is correct, PDO's, NAO's, and ENSO's predicted phases may be used *together* to produce long-term forecasts.

Currently each of the three oscillations has it's own, independent, effect on weather patterns. The usage of all of these three major oscillations to converge into one climatic tool/engine may produce a more accurate forecast.

2-METHOD OF ANALYSIS

I began by looking for years having similar oscillation phases through reviewing and comparing graphs based on the oscillation's indices (Fig 1a, 1b, & 1c). I found that the two years of 1950 and 1975 have the strongest similarities in all three phases.

To confirm what Figures 1a, 1b, and 1c imply, the indices in tables 2a, 2b, and 2c were taken into strong consideration. Although the graphs are formed from the indices, they are compiled as the yearly average, and therefore are occasionally skewed. When taken into consideration, the indices prove a much more valid tool for determining the current regime of any oscillation.

In the instance of the years 1950 and 1975, the indices coincide with the graph's initial impression (see Table 2a, 2b, & 2c). In all of the oscillations, the average monthly values for 1975 and 1950 are very similar. In certain months, the two years match up almost perfectly for some oscillations; for example, the July values for the SOI (Southern Oscillation Index) in 1950 and 1975 are identical. Also, note that the PDOI (Pacific Decadal Oscillation Index) values for April are quite similar.

Because of the similarities previously mentioned, the years of 1950 and 1975 were chosen as the best candidates for comparing temperature anomalies. Given that the yearly averages do not entirely coincide in the NAO, the temperature anomalies for the Atlantic coastal regions can be expected to depart slightly between the two years; however, both the SOI and PDOI have yearly averages for 1950 and 1975 that are very comparable (see Tables 2a – 2c).

Oscillation graphs based on indices

Fig 1a

WINTER NAO INDEX (1825 -2001)

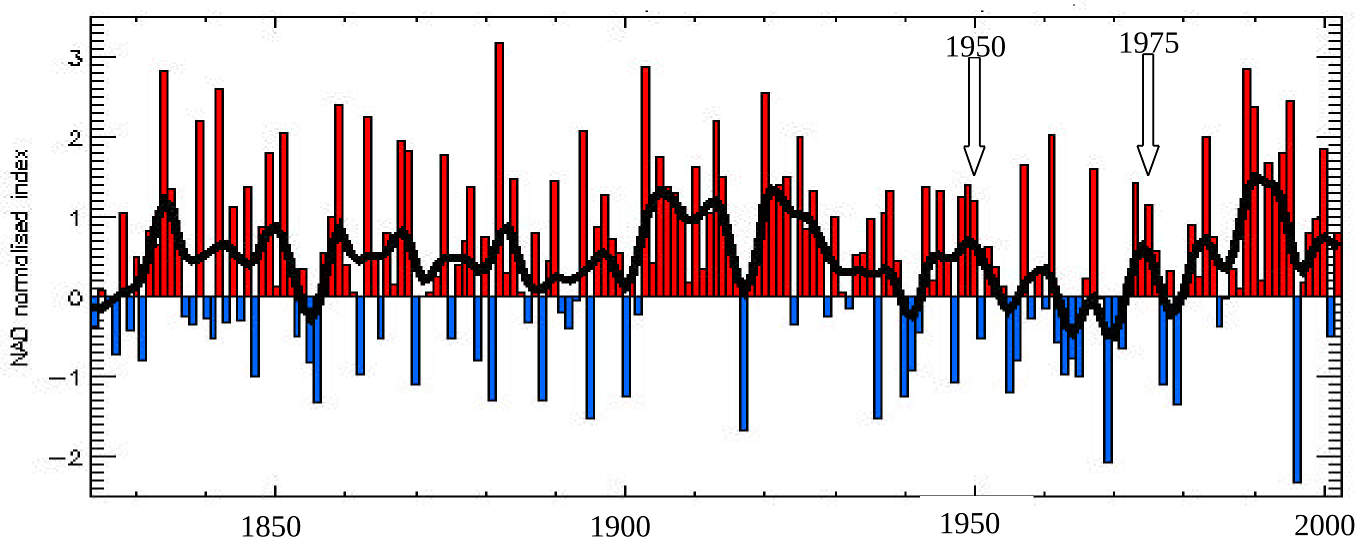


Fig 1b

SOUTHERN OSCILLATION INDEX (1950-1999)

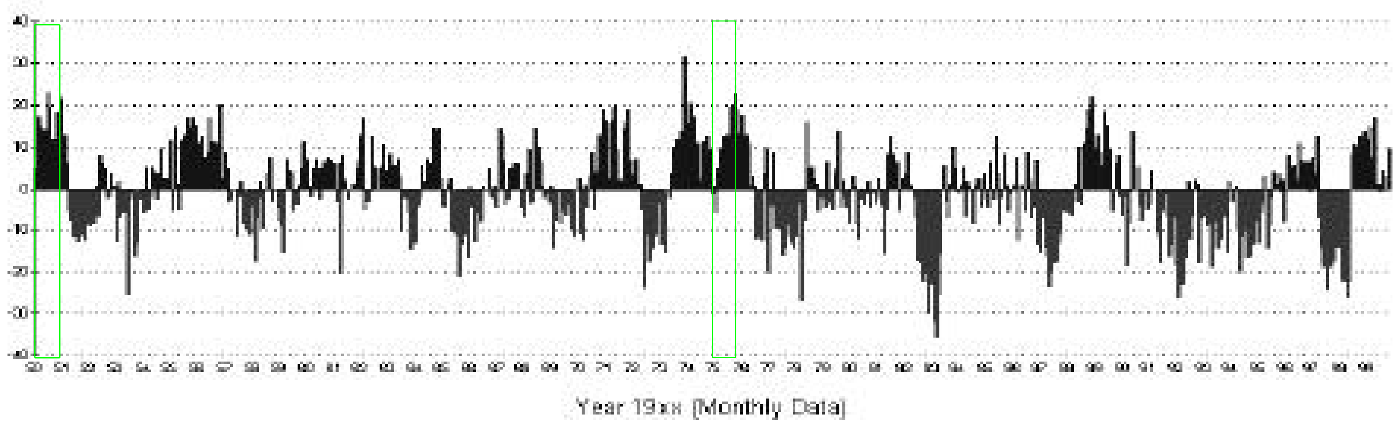
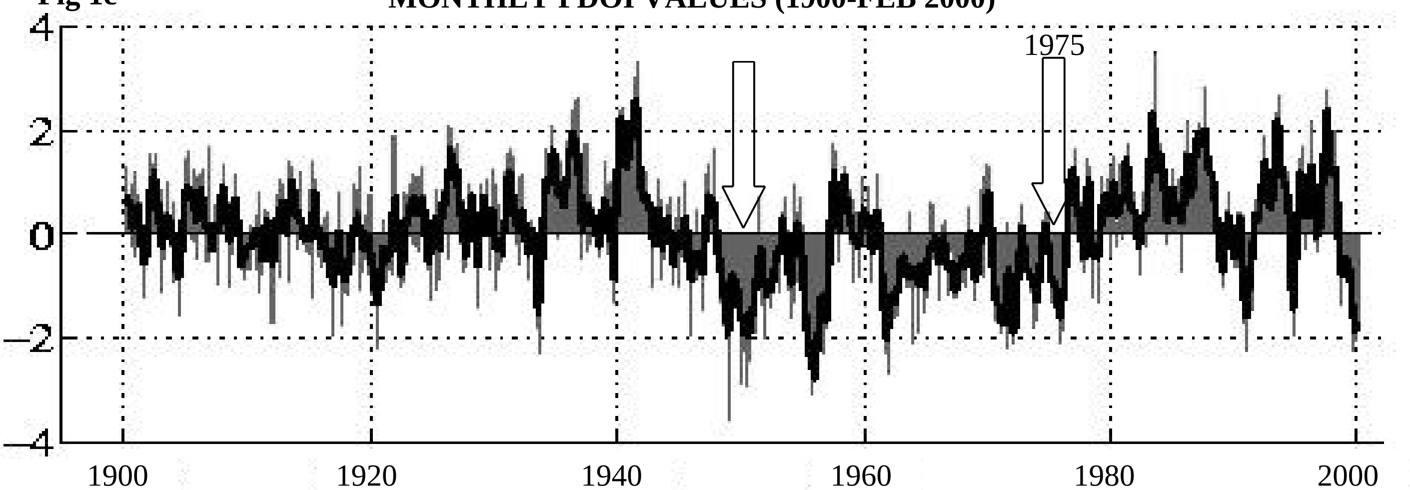


Fig 1c

MONTHLY PDOI VALUES (1900-FEB 2000)



See bibliography for references.

Oscillation Indices for 1950 and 1975

SOI (Table 2a)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVRG
1950	5.1	17.6	17.6	16.8	7.6	26.9	21.1	12.3	6.9	17.1	12.5	23	15.37
1975	-4.9	5.3	11.6	14.4	6	15.5	21.1	20.7	22.5	17.7	13.8	19.5	16.17

NAOI (Table 2b)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVRG
1950	0.55	3.31	0.82	1.61	-1.73	1.26	-0.87	-0.28	1.51	0.78	0.78	-1.88	0.49
1975	2.43	0.4	-1.26	-0.84	-2.42	0.18	0.63	0.08	1.75	0.39	0.86	-1.57	0.05

PDOI (Table 2c)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVRG
1950	-2.13	-2.91	-1.13	-1.2	-2.23	-1.77	-2.93	-0.7	-2.14	-1.36	-2.46	-0.76	-1.81
1975	-0.84	-0.71	-0.51	-1.3	-1.02	-1.16	-0.4	-1.07	-1.23	-1.29	-2.08	-1.61	-1.1

See bibliography for references.

3-CONNECTING INDICES TO ANOMOLOUS TEMPERATURES

The years of 1950 and 1975 are very similar in the values of their indices, but are those similarities also present in seasonal temperature values? In order to answer this question, temperature information for selected regions compiled by the International Research Institute (IRI) was used. In Figures 2a through 2l, the monthly temperatures are shown as their departure from the mean monthly temperature values. Generated by IRI, these charts effectively express the anomalous temperatures as lower or higher than the average.

The time scale of the charts ranges from the year 1950 to 1998. Only the most applicable two of the four seasonal values are shown. For all four seasons' charts, see bibliography. The values of the years in question (1950 and 1975) are easily visible.

The temperatures for Lisbon, Portugal (Fig 2e and 2f) in 1950 and 1975 are not quite as strongly correlated. This might be due to the region being pre-dominantly affected by the NAO, whose phases are not as strongly related in these years as are the PDO and ENSO. For the areas defined in the PDO and ENSO categories, the temperature anomalies are very notably correlated. The '50 and '75 values for Darwin (Fig 2a and 2b) are nearly identical, especially in the September-November season (Fig 2b).

Seasonal Temperature (departure from mean)

Darwin, Australia

December-February

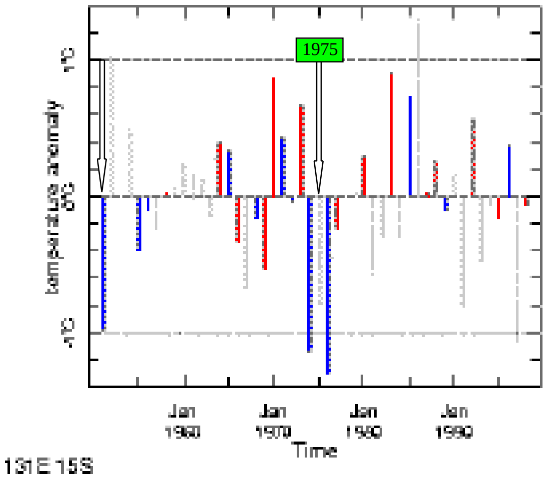


Fig 2a

September-November

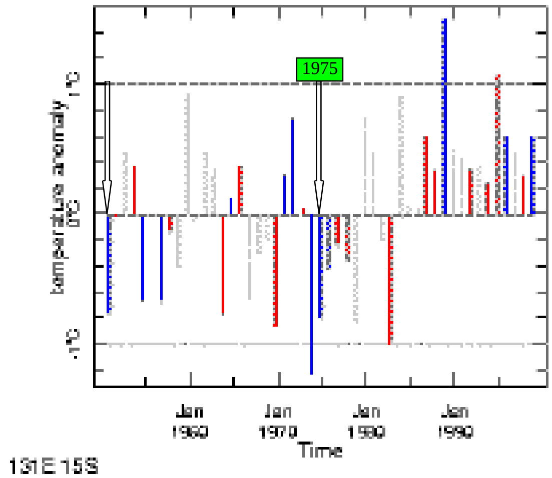


Fig 2b

San Francisco, California USA

March-May

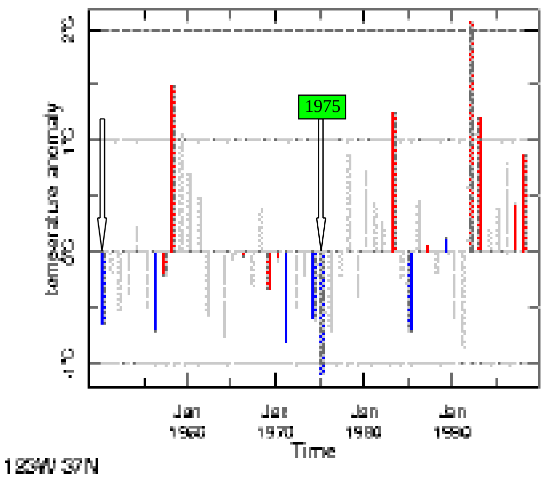


Fig 2c

September-November

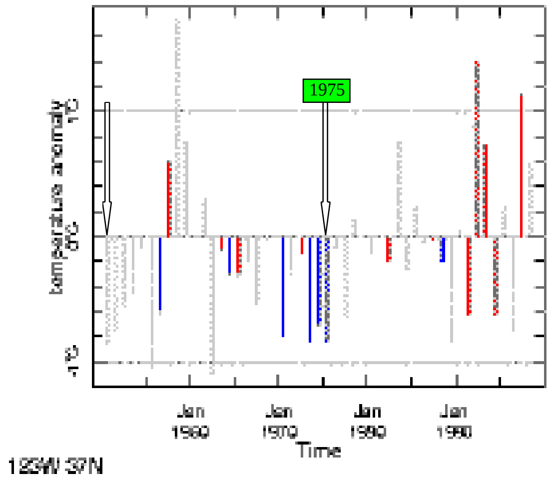


Fig 2d

See bibliography for references.

Seasonal Temperature (departure from mean)

(cont.)

<u>Lisbon, Portugal</u>

March-May

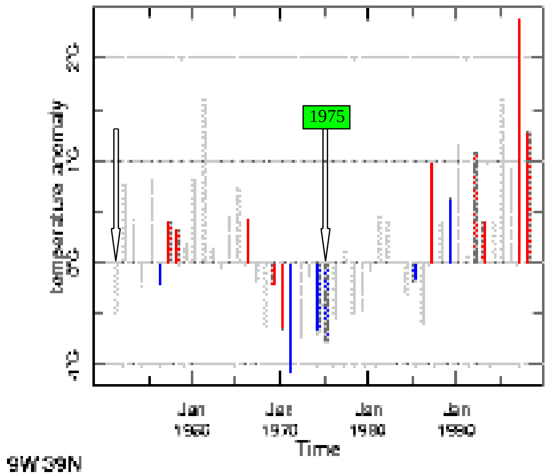


Fig 2e

September-November

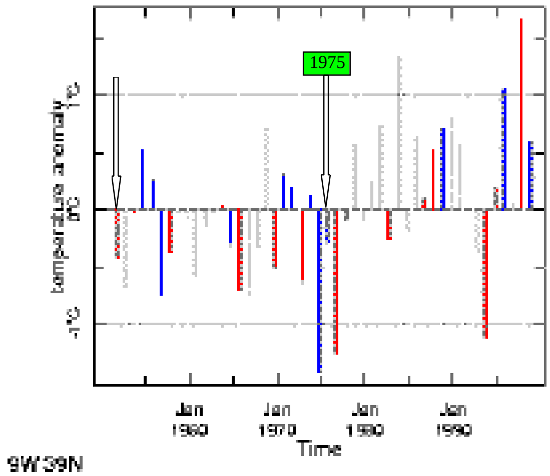


Fig 2f

<u>Antananarivo, Madagascar</u>

December-February

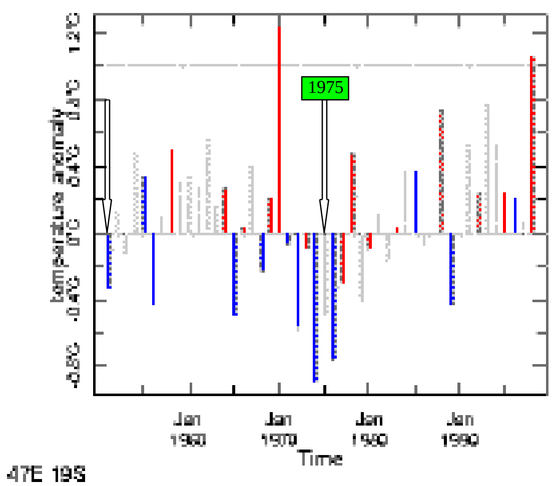


Fig 2g

March-May

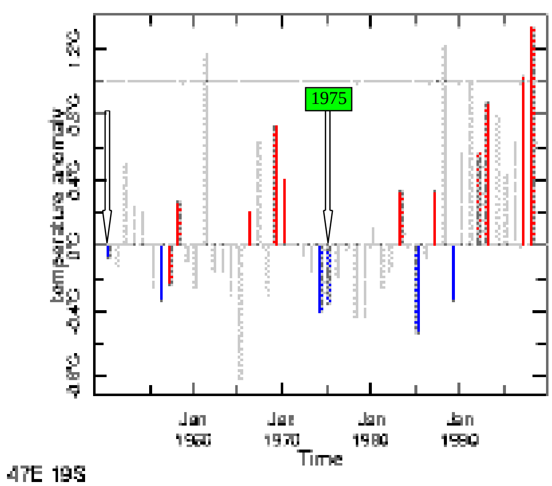


Fig 2h

See bibliography for references.

Seasonal Temperature (departure from mean)

(cont.)

Camagüey, Cuba

December-February

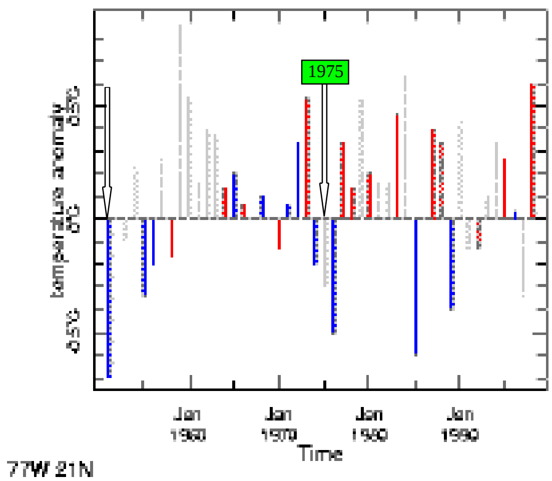


Fig 2i

June-August

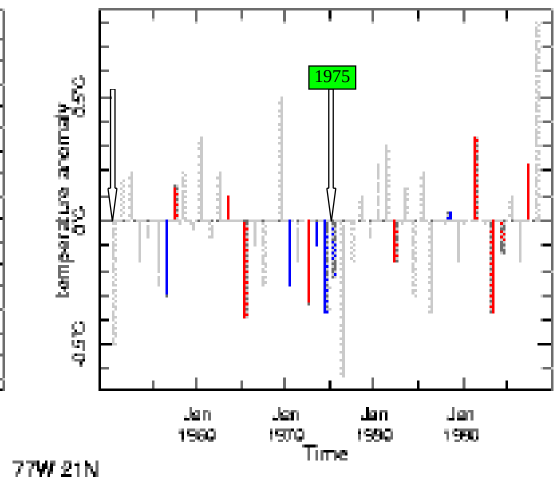


Fig 2j

Kodiak, Alaska USA

March-May

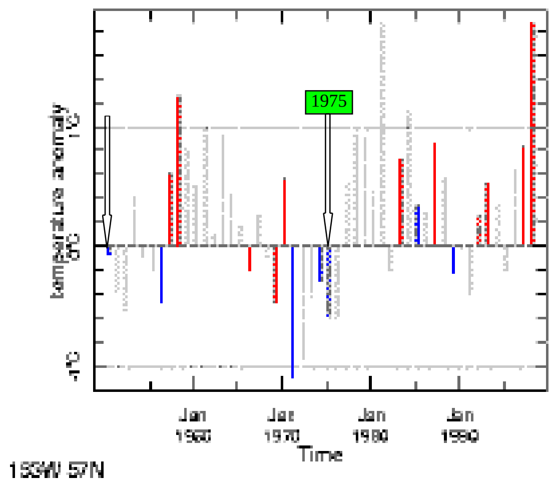


Fig 2k

September-November

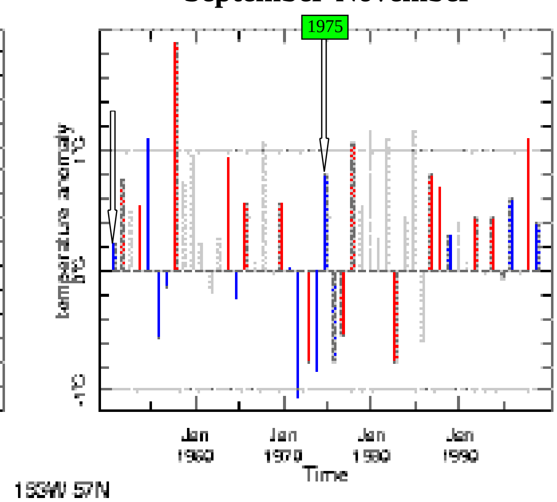


Fig 2l

See bibliography for references.

4-DISCUSSION

The majority of previous studies focus on the individual effect of one oscillation. Viewing each oscillation as it's own independent closed system, then using the oscillation to identify weather patterns, may not be the most effective method of observing the oscillation's impact on climate. The Earth's climate system is subject to countless factors, all of which may interact with one another.

In Chaos: Making a new Science, James Gleick refers to a controversial scientist by the name of Thomas S. Kuhn. Gleick says, "He emphasized a contrast between the bulk of what scientists do, working on legitimate, well understood problems within their disciplines, and the exceptional, unorthodox work that creates revolutions" (Gleick 1987). In effect, this describes the approach applied to this paper. The quote identifies how a broad, integrated view of a situation, especially with respect to scientific phenomena, can be more productive than focusing on a single component or factor. A simple solution can be overlooked for decades until someone is perceptive enough to see outside their immediately assigned discipline. Gleick reiterates, " …discoveries often come from people straying outside the normal bounds of their specialties" (Gleick 1987).

I have previously searched for a connection between Pacific Northwest climate and the PDO. I found very little correlation as a result of my inquiry. Through applying PDO, NAO, and ENSO; however, I have found many connections between these oscillations and climatic patterns. This serves to expand on the idea that a general application of observations can be an effective way to approach a problem.

A paper written by Gilbert Thomas Walker in 1923, entitled Seasonal Variations of Weather, implies that Walker considers not one, but three separate oscillations to be contributing factors in global climate. Walker states, "we can perhaps best sum up the situation by saying that there is a swaying of press[ure] on a big scale backwards and forwards between the Pacific Ocean and the Indian Ocean, and there are swayings, on a much smaller scale, between the Azores and Iceland, and between the areas of high and low press[ure] in the N. Pacific"(Walker 1923). I believe the three oscillations he described are, in fact, the NAO, PDO, and ENSO. As expressed in Walker's writings, all three oscillations are correlated with climate. Some more than others but, none the less, all are applicable.

5-CONCLUSION

The similarities between the two chosen years are obviouse; however, making predictions based on these facts are another matter. Predicting the oscillations' phases and applying them to a similar historical year's climate is a possibility. One may be able to make a forecast based on how the predicted phases of the oscillations have historically affected climate.

The complexity of our climate is impossible to sum up in a simple swaying of tradewinds or oscillating SSTs. Oceanic oscillations explain much of long-term global climate patterns, but too many other influential variables are present for a completely accurate climatic prediction to be made.

James Gleick explains, "A new science arises out of one that has reached a dead end"(Gleick 1987). The data required for a twenty to thirty year oscillation is far more than what is presently available, and the need for further research is as strong as ever. The time is ripe for new methods of predicting and new applications for our knowledge. Only time may tell what discoveries currently lie just beyond our grasp.

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